Part 1. Report Cover

Report Number: DLAW003E **Report Date:** 18 May 01

Previous Report Number: 99AYP015 **Report Date:** 30 Apr 91

Title: Performance Oriented Packaging Testing of a PPP-B-601, Type 2, Style A, Domestic, Cleated-Plywood Box With Skids, 28 inches by 20 inches by 16 inches (ID), Containing 5.6 Quart, Tall, Round, Paint Cans Fitted with Hazloc Rings, Containing 1-Quart Plastic Bottles (Qty of 6) for Liquids-Packing Groups I, II, and III (All Surface Modes) (Not acceptable for Military Air)

Responsible Individual: Francis S. Flynn

Performing Activity: LOGSA Packaging, Storage, and Containerization Center
ATTN: AMXLS-T
11 Hap Arnold Boulevard
Tobyhanna, PA 18466-5097

Performing Activity's Reference(s): 9HTRR; TE 35-97; AMC 13-88

Report Type: Interim Final

DTIC Distribution: N/A

Requesting Organization:
Defense Logistics Agency
Defense Distribution Center
ATTN DDC J-3/J-4-0
2001 Mission Drive
New Cumberland PA 17070-5000

Requesting Organization's Reference(s):
DLA Memo, 6 Dec 00

Test Results: ___ single _X_ combination ___ composite

Section I. Pre-test Conditions

For initial testing, one box was received in new condition, from the DDSP post box fabrication shop.

The following identification schema designates the packaging specimen used for the test(s) indicated.

Specimen No.	Test
A	stack test
A	repetitive-shock vibration test
A	flat onto bottom, drop test
	flat onto long side, drop test
	flat onto top, drop test
	flat onto short side, drop test
	bottom corner, drop test

Section II. Summary

A. Drop test - *1.8 m* **PASS**

flat onto the top (face 1)	PASS
flat onto the bottom (face 3)	PASS
flat onto long side (face 4)	PASS
flat onto short side (face 6)	PASS
bottom corner (5-2-3)	PASS

B. Leakproofness test -
restrained under water/soap over seams N/A

C. Internal pressure test/Hydrostatic pressure test (liq.) - N/A

D. Stacking test - *static load, 2,000 lb, 24 hr* **PASS**

E. Vibration standard - *repetitive-shock, rotary motion*
4.2 *Hz., 1 hr* **PASS**

F. Water resistance test (fiberboard box) - N/A

G. Compatibility test (liq. in plastics) - N/A

Test Results (continued)

Section III. Discussion

A. Drop test: *49 CFR §178.603*

___ cold conditioned (0° F, 72 hr)
_X_ ambient conditions (~72° F)
___ standard conditions (50% RH & 23° C)

No.	Ht.	Orientation	Results
A	1.8 m	Flat onto box bottom (3)	Pass/No leaks/rupture; entire contents retained
A	1.8 m	Flat onto box long side (4)	Pass/No leaks/rupture; entire contents retained
A	1.8 m	Flat onto box top (1)	Pass/No leaks/rupture; entire contents retained
A	1.8 m	Flat onto box short side (6)	Pass/No leaks/rupture; entire contents retained
A	1.8 m	Diagonally onto bottom joint corner (5-2-3)	Pass/No leaks/rupture; minor crushing of the 5-2-3 corner; contents retained completely within the box

For each orientation for the drop test, a quick release hook fixed to an overhead crane was used to lift the container for each 1.8 m drop. The impact surface was a ¾-inch steel plate bolted to the concrete floor.

In conducting the drop test, all five drops (flat bottom, flat long side, flat top, flat short side, and bottom corner) were performed on the same configuration. The decision to use the same container (configuration) for all five drop orientations was based on the relatively minimal damage demonstrated during previous testing of plywood boxes with different inner containers or articles. Five drops per configuration exceeds *49 CFR §178.603* requirements, as well as both UN and ASTM recommendations (i.e., one drop on a side or corner per box). The use of one configuration for multiple tests and drops is DOD policy as stated in DLAD 4145.41/AR 700-143/AFJI 24-201/NAVSUPINST 4030.55A/MCO 4030.40A, Packaging of Hazardous Material. Also per this policy, any failed orientation(s) can be repeated using another configuration.

B. Leakproofness test: *49 CFR §178.604*

N/A. The leakproofness test was not conducted on the box, because the packaging is not intended for the containment of liquids.

C. Internal Pressure/Hydrostatic Pressure test: *49 CFR §178.605*

N/A. Testing for the maintenance of internal pressure is not required for this configuration. See note on page C2.

Test Results: Section III (continued)

D. Stacking test: *See 49 CFR §178.606.*
___ standard conditions (23° C & 50% RH)
_X_ ambient conditions (~72° F)
___ high temperature conditions (104° F)

No.	Length	Type	Load/Force	Peak Force	Results	Stability Maintained?
A	24 hr	Static	2,000 lb	N/A lbf	Pass	Yes

A static top load (2,000 lbs) was used for the stack test, because it could hold the load constant for the required 24-hour timeframe. The total top load applied on the empty box was greater than the minimum required for one box based on the outside box height and the gross packaged weight. The top load was to simulate a stack of identical packagings that might be stacked on the packaging during transport.

E. Vibration test: *See 49 CFR §178.608.*

No.	Frequency	Duration	Results
A	4.2 Hz	1 hr	Pass. No leakage, rupture, or damage

To be in compliance with U.S. Department of Transportation standards for packagings bearing the United States mark (USA) as a component of the packaging certification marking (*49 CFR §173.24a(a)(5)*), the vibration test was performed, as a means to determine capability. The test was conducted as prescribed by ASTM D 999, method A2 (Repetitive Shock Test (Rotary Motion)). The test was run for 1 hour, using the plywood box packaging. The packaging was tested using a 2,000-lb vibration table (rotary motion) that had a 1-inch-vertical double amplitude (peak-to-peak displacement) such that the packaging was raised from the platform to such a degree that a piece of steel strapping (1.6 mm) could be passed between the bottom of the package and the platform.

F. Water resistance (Cobb Method) test (fiberboard): N/A

G. Compatibility test (plastics packagings only): N/A.

Test Personnel

The following personnel performed the aforementioned testing, or had a role in the testing, evaluation, and/or documentation, as reported herein-- Richard D. LaFave, Samuel Baroody, Bruce W. Samson, Timothy L. Reimann, and Karen K. Kimsey

References

A. Title 49 Code of Federal Regulations, Parts 106-180, Spring 2001, current as of 12 Jan 01

B. International Air Transport Association Dangerous Goods Regulations, 40th edition, 1 January 1999

C. ASTM D 4919, Specification for Testing of Hazardous Materials Packagings.

D. ASTM D 999, Standard Method for Vibration Testing of Shipping Containers.

E. ASTM D 951, Standard Test Method Water Resistance of Shipping Containers by Spray Method.

F. TAPPI Standard: T 441 Water Absorptiveness of Sized (Non-Bibulous) Paper and Paperboard (Cobb Test).

G. Recommendations on the Transport of Dangerous Goods, sixth revised edition, United Nations, New York, 1990.

H. DLAD 4145.41/AR 700-143/AFJI 24-201/NAVSUPINST 4030.55A/ MCO 4030.40A, Packaging of Hazardous Material, 23 Jul 96

I. AFJMAN 24-204/TM 38-250/NAVSUP PUB 505/MCO P4030.19G/DLAI4145.3, Preparing Hazardous Materials for Military Air Shipments, 1 Mar 97

Equipment

Item	Manufacturer	Serial No.	Calibration Expiration Date
2,000-lb vibration table	L.A.B Skaneateles, NY	G23605	*see note*
30,000-lb compression tester	Gaynes Engr. Co. Franklin Park, IL	G20950	4/02
release hook	Gaynes Engr. Co. Franklin Park, IL	18211-1	N/R

Note. Equipment is calibrated in accordance with International Safe Transit Association test equipment verification requirements.

Appendix A

Test Applicability

Pass/fail conclusions were based on the particular box specimens, test loads, and the limited quantities submitted for test. Extrapolation to other materials, other manufacturers, other applications, different inner packagings, container sizes, or lesser inner quantities is the responsibility of the packaging design agency or applicable higher headquarters. Extrapolation of test results based on less than the minimum recommended number of test specimens is also the responsibility of the packaging design agency or applicable higher headquarters.

Testing was performed per *Title 49* Code of Federal Regulations.

Performance testing was undertaken and completed at the request of an agency responsible for shipment of the dangerous good(s). The completion of successful required performance tests does not, by itself, authorize the marking and transportation of the dangerous good(s). Applicable modal regulations should be consulted concerning the relationship of performance testing completed and the dangerous good(s).

The required performance tests are intended to evaluate the performance of the packaging components. The criteria used to evaluate packaging performance is whether the contents of the packaging are retained within the outer packaging, should damage to the outer packaging occur, and secondly, if any inner packaging of hazardous materials leaks, ruptures, or is damaged so as to affect transportation safety. The successful completion of the required tests does not ensure the undamaged delivery or survivability of the actual commodity/item. Separate testing is necessary to assure the stability of any explosive item.

Before a configuration can be certified by the person(s) authorizing shipment, the appropriate packaging for the particular hazardous materials and mode of transportation must be determined, and the item(s) must be prepared for shipment per applicable regulations. The chosen configuration must have been performance tested in accordance with the size, the shape, and the weight constraints posed by the configuration to be certified. The testing reported herein should not be construed as blanket certification of any configuration which simply uses the performance tested outer box. Packaging paragraphs apply.

Appendix B

Test Data Sheet

Section I. Test Product

Physical State: ___ solid _X_ liquid ___ gas ___ aerosol

Amount Per Container:

Item Weight-- 20.04 lbs. (6 ea @ 3.34 lbs)
Tare Weight-- 101 lbs.
Gross Weight-- 121.04 lbs.

Section II. Test Parameters

Drop Height: Ref: *49 CFR §178.603*

_X_ **1.8 m; 71 in.** (PG I, II, & III, SG ≤1.2 or solids)
___ 1.2 m; 47 in. (PG II & III, SG ≤1.2 or solids)
___ 0.8 m; 32 in. (PG III, SG ≤1.2 or solids)
___ ___ m; __ in. (other, PG ___, SG ___)
from-- ___ PG I: SG x 1.5 m, SG x 59.06 in.
___ PG II: SG x 1.0 m, SG x 39.37 in.
___ PG III: SG x 0.67 m, SG x 26.38 in.

Stacking Weight Formula, Liquids – DLA

Variables		Inputs	Calculations
h	height, drum/box	21	
n	# stacked containers	XXXXXXXX	5.62
w1	weight, drum/box	52	52
w2	weight, bottle/can(w/pads)	0	0
w3	weight, inner container	3.34	20.04
q1	# inner containers	6	6
v1	max. volume, 1 inner container	0.25	0.25
v	total volume	XXXXXXXX	1.5
w4	weight, item (unpacked)	0	0
W5	weight, absorbent	49	49
W	total weight	XXXXXXXX	121.04
C	constant	1	
A1	Stacking weight-PG I	XXXXXXXX	**626.66**
A2	Stacking weight-PG II	XXXXXXXX	**660.47**
A3	Stacking weight-PG III	XXXXXXXX	**711.20**
A11	Stacking weight, rounded-PG I	XXXXXXXX	**627**
A21	Stacking weight, rounded-PG II	XXXXXXXX	**661**
A31	Stacking weight, rounded-PG III	XXXXXXXX	**712**

Appendix B (Continued)

Section II. Test Parameters (continued)

NOTE: A1 = (n-1)*(w+(1.2*v*8.3*0.98))*(c), Packing Group I
A2 = (n-1)*(w+(1.8*v*8.3*0.98))*(c), Packing Group II
A3 = (n-1)*(w+(2.7*v*8.3*0.98))*(c), Packing Group III

A1 = stacking weight in pounds, PG I
A2 = stacking weight in pounds, PG II
A3 = stacking weight in pounds, PG III
n = (118/h), minimum number of containers that when stacked, reach a height of 3 m
w = w1+(w2*q1)*(w3*q1)*w5, total weight in pounds
v = v1*q1, total volume
c = either 1.5 (the compensation factor that converts the static load of the stacking test into a load suitable for dynamic compression testing), or 1.0 (static top load)

Section III. Equivalencies of Liquids

	Specific Gravity see note 1	Total (Each) Amount per Container	Gross Weight (pounds)	Test Weight (kilograms)
water	1.0	20.04 lb (3.34)	121.04	55.02
PG I	1.2	24.05 lb (4.01)	125.05	61.43
PG II	1.8	36.72 lb (6.12)	137.72	62.68
PG III	2.7	54.11 lb (9.02)	155.11	70.50

Note 1. Equivalent specific gravity derived from drop height as follows-- PG factor x density (or SG) = drop height, thus
SG = drop height/PG factor (49 CFR §178.603)
PG I: 1.5 m x SG = 1.8 m, thus SG = 1.2
PG II: 1.0 m x SG = 1.8 m, thus SG = 1.8
PG III: 0.67 m x SG = 1.8 m, thus SG = 2.7
Unless otherwise computed for more dense liquids, water (SG = 1) represents a solution having a specific gravity of 1.2 or less.

Appendix C

Packaging Data Sheet

Section I. Exterior Shipping Container

Packaging Category: ___ single _X_ combination ___ composite

UN Type: Plywood boxes (*49 CFR §178.514*) UN Code: 4D

Specification No.: PPP-B-601; Style A; Cleated plywood box with skids; 52 lbs.; 28" x 20" x 16" (ID); 30½" x 22¼" x 21" (OD)

Manufacturer: Defense Distribution Region East Susquehanna, West Container Fabrication Branch, Mechanicsburg, PA 17055

Date(s) of Manufacture: March 2001

Closure Method: The outer plywood box was sealed using 8 penny cement coated sinkers. The box was then banded with 2 girthwise and 2 lengthwise flat steel straps, ¾" by 0.023". (See drawing)

Cushioning/Dunnage: cellulose fiber (approx. 49.0 lbs)

Additional Description:

a. A 32" x 28" x 48" gusseted 4-Mil-poly bag was first placed in the plywood box for the purpose of encapsulating the absorbent and the test product. Approximately 2¾ inches of firmly-packed, loose-fill absorbent cushioning was placed in the bottom of the box. Six cans were placed on the absorbent. Inside each can was a 1-quart plastic bottle wrapped with bubble wrap. The 1-quart bottles were first wrapped and then placed in the cans. See drawing. More loose-fill absorbent was then firmly packed around, and over the cans. Approximately 2½ inches of loose-fill absorbent separated the cans from each other and from the sides of the box. The loose-fill absorbent must be firmly packed, especially around the cans. 2¾ inches of firmly packed, loose-fill absorbent covered the cans. To pack the loose-fill absorbent, the use of a tamping stick is recommended.

b. For this configuration, either firmly-packed, fine grade vermiculite or either of the following, firmly-packed cellulose fiber absorbent products, "HAZMATPAC® Absorbent A-900" or "Absorption Corporation Absorbent GP", can be used without any notable difference in performance. Inner packagings have a tendency to migrate if the loose fill material is not firmly packed, especially along the bottom of the container.

Bag Manufacturer: Quality Packaging Systems of Warren, Inc., 24260-2 Mound Road, Warren, MI 48091-5324

Absorbent Manufacturer: Absorbent GP, 1051 Hilton Ave, Bellingham, WA 98225

Appendix C (Continued)

Section II. Intermediate Packaging

Quantity of Inner Containers: 6 Capacity: 5.6 Quart

Specification Type and No(s).: N/A

Type: Tall, round, unlined, paint can with friction ring lid

Manufacturer/Distributor: Codes embossed on bottom not discernable

Material(s): Steel tin plate Date(s) of Manufacture: N/A

NSN: N/A

Tare Weight (empty can): 0.88 lb
0.40 kg

Filled Weight: 3.34 lb ea

Dimensions: 10.5 in. high; 6.5 in. diameter

Closure (Method?Type): The can is to be closed using a rubber mallet to tap the entire friction lid securely in place. The plastic locking ring is then placed on top of the can. The plastic ring is installed by using a rubber mallet to tap the entire ring over the upper edges of the can. Care must be exercised to avoid denting or creasing the friction-lid can.

Closure Specification Number(s): N/A

Closure Manufacturer: Hazmat Pac, Houston, TX 77023

Closure Dimensions: 5½ in. (opening)

Secondary Closure: Hazloc Ring (plastic locking ring)

Secondary Closure Specification Number(s): N/A

Secondary Closure Dimensions: 5½ inch opening

Additional Information: This test report can only be cited when a HAZLOC or ICC ring is applied to the cans.

Note. Manufacturer's certification documentation sent to DLA, ATTN: DDC J-3/J-4-0, as an attachment with this hard copy report only. Either the HAZLOC Ring or the ICC Ring can be used with the 5.6 quart can.

Appendix C (Continued)

Section II. Inner Packaging/Article

Quantity of Inner Containers: 6 Capacity: 1 Quart

Specification Type and No(s).: N/A

Type: Wide mouth, plastic bottle

Manufacturer/Distributor: Not marked

Material(s): Polyethylene Date(s) of Manufacture: N/A

NSN: N/A

Tare Weight (empty can): 0.165 lb

Filled Weight: 2.46 lb ea

Dimensions: 6.5 in. high; 3.6 in. diameter

Closure (Method?Type): Plastic screw cap

Closure Specification Number(s): N/A

Closure Manufacturer: N/A

Closure Dimensions: 3.45 in. in diameter (OD)
½ in. in height (OD)

Secondary Closure: Filament-reinforced tape (1 pc)
Placed around the bottle neck to secure the cap

Secondary Closure Specification Number(s): NSN-- 7510-00-582-4772
(1) A-A-1687B, Amendment 1 (marked) [canceled Jan 96]
(2) PPP-T-97, type II (medium tensile), class B (transparent) [canceled Jan 96]
(3) ASTM D 5330-93, type II (medium tensile)

Secondary Closure Dimensions: 1 inch wide

Additional Information: Each bottle was individually wrapped in bubble wrap and secured using 1-inch filament tape. The six liquid filled bottles were then placed in the 5.6-quart cans. See drawing.

Note. Manufacturer's certification documentation sent to DLA, ATTN: DDC J-3/J-4-0, as an attachment with this hard copy report only. Either the HAZLOC Ring or the ICC Ring can be used with the 5.6 quart can.

Appendix D

Rationale

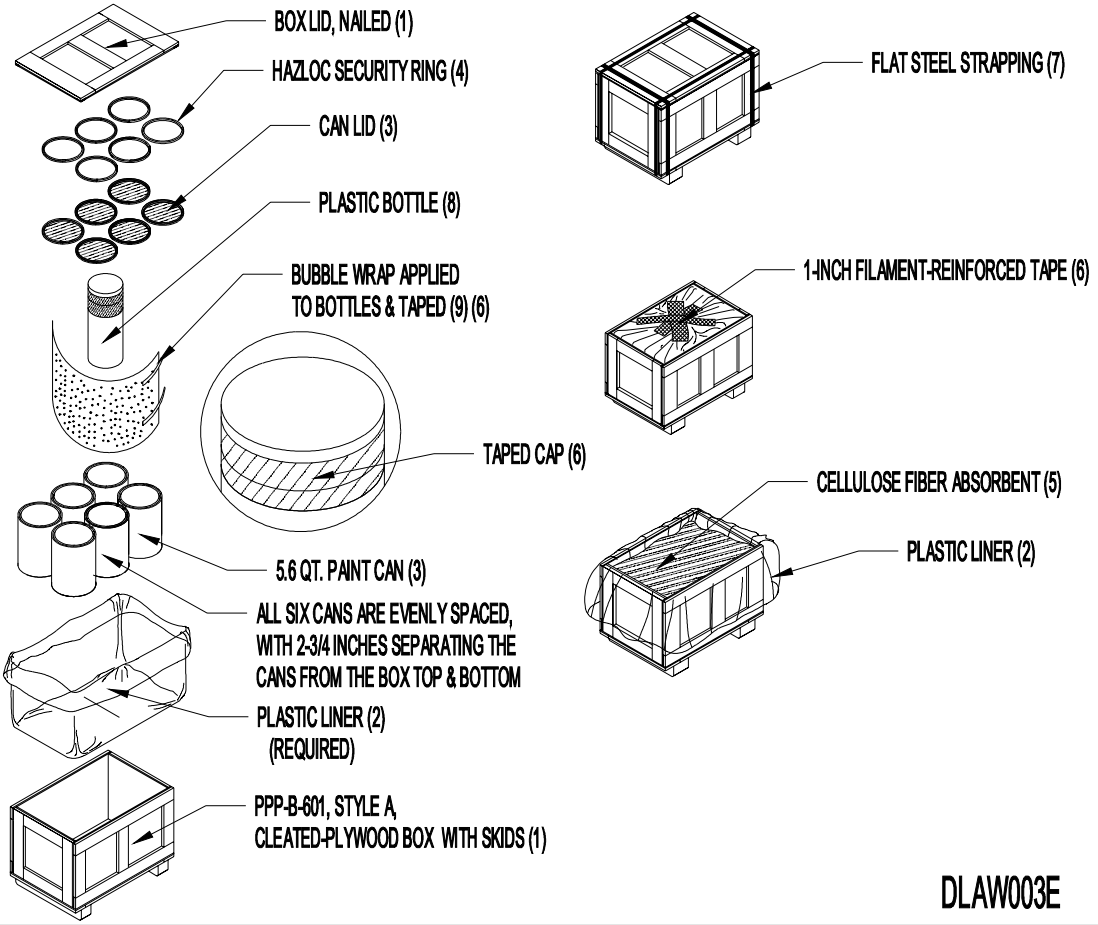
The equivalent of Packing Group I (great danger) testing was requested for a plywood box, having as the intended contents six, 5.6-quart, round, metal cans, each containing a 1-quart plastic bottle with a screw cap. The lid of the 5.6-quart can is to be secured with either an ICC or HAZLOC locking ring. The configuration to be tested is intended to be applicable to a large assortment of liquid products of equal or lesser volumes contained in round, plastic bottles. For lesser volumes, variations to testing requirements can be found in 49 CFR §178.601(g).

For testing, substitution for the actual hazardous lading is permitted by 49 CFR §178.602(c). Water can be used as a substitute liquid.

Per the requesting activity, cellulose fiber was used as an absorbent material and/or cushioning.

One combination packaging, made to the above described configuration with 6 cans, was initially subjected to drop and vibration testing as prescribed in ASTM D 4919. These tests are designed to simulate the shock and vibration a package (configuration) may encounter when being shipped worldwide by truck, rail, or ocean going transport. The order of testing was vibration, then drop testing. Prior to the rough handling testing of the packed box, static loading was performed on the empty box. This is a U.S. DOT approved method of stack testing, especially when the combination packaging has wide applications.

Drawing



ITEM	DESCRIPTION
1	PPP-B-601, STYLE A, CLEATED-PLYWOOD BOX WITH SKIDS, 28 x 20 x 16 inches (ID)
2	THE BOX MUST HAVE A PLASTIC LINER, 4-MIL POLYETHYLENE, 32 X 28 X 48 INCHES, GUSSETED BAG (REQUIRED)
3	5.6 QUART, ROUND, METAL PAINT CAN WITHOUT BAIL, QTY. 6
4	HAZLOC brand PLASTIC LOCKING RING, QTY. 6
5	CELLULOSE FIBER ABSORBENT, OR VERMICULITE, A-A-52450
6	1-INCH WIDE, PRESSURE-SENSITIVE TAPE, FILAMENT-REINFORCED, IAW ASTM D5330, TY II
7	3/4 x .023 IN. STEEL STRAPPING, FLAT, TYPE 1, FINISH A, IAW ASTM D3953 2 GIRTHWISE BANDS, 2 LENGTHWISE BANDS
8	1 QUART, WIDE-MOUTH, PLASTIC BOTTLE, QTY. 6
9	3/8 INCH, BUBBLE WRAP, APPLIED TO CONE TOP CAN & TAPED, SUFFICIENT TO FIT SNUG IN CAN, QTY. 6